

post, which were all state enterprises under post office control. "The principle of natural liberty, sound as it might have been as a system for producing wealth, stood condemned as causing abuses and deficiencies in service." But nothing is said about the possibilities of corruption in government!

Under government ownership, however, the revenues were far less than the estimates made in 1868. Revenues did not rise as fast as working expenses, and the expansion of the system to non-profitable areas added to the losses. Under private ownership, prior to 1868, £ 59 per year net annual profit was gained from each unit of labor; in 1875, under government ownership, this had dropped dramatically to £ 9. And more staff and supervisory personnel were required under government ownership.

With the coming of the telephone in 1878 and wireless (radio) in 1896, competition for the telegraph increased, and even with more sophisticated devices such as the teleprinter, decline of business continued, with deficit cost to the government increasing. Waiting time for a telephone in 1971 was four to five months, so the telegraph was still essential in many areas.

"The greatest days of the telegraph, however, were between 1850 and 1914." The telegraph was a key event in the history of the world, contributing enormously to the economic life of all peoples in civilization as we know it, nullifying the gaps between nations, and speeding the interchange of ideas and goods among them.

While the book is essentially, as the author says, a social and economic history, the information contained in it should be of value to those in the technological field. References to patents and other published material are quite voluminous, but unfortunately are to British publications only.

An economic lesson we can learn from the book is expressed by the author in this way: "The accounts of the telegraph department seemed to demonstrate what was previously feared, that a government could not compete in economy with a commercial enterprise subject to competition."

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Bell: Alexander Graham Bell and the Conquest of Solitude. By Robert V. Bruce. Boston: Little, Brown & Co., 1973. Pp. xi+564; illustrations. \$12.50.

Invention does not reflect the character of the inventor in the way scientific theory mirrors the personality of the scientist. A scientist is

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free to explain a phenomenon in the manner he wishes, and the mode he selects is a consequence of his background and his individualistic style of thought. Voices and other sounds can be transmitted over a wire by electricity in a variety of ways, but each of these ways is so closely tied to the technology available that no observer can detect the mark of personality on the design. Only in architecture, where a theme is repeated in many different variations, can the technologist exhibit his ideas in a way that to know the work is to know the person. It follows that biography is more important in understanding the history of science than the history of technology.

What is made of a new idea by others, whether that be in science or technology, through interpretation and modification confers historical value on the original idea. So that except for very limited significance, the history of technology is less interested in invention and the biographies of inventors than it is interested in technological innovation, which is concerned with larger questions of social and economic change. The biography of Alexander Graham Bell, a man who disassociated himself from his invention before it became a successful innovation, is of limited interest to a historian of technology. Robert V. Bruce's biography, which ranges so broadly, forces us to wonder why biographies of inventors have been of such little use and what the role of biography might play in the history of technology.

What kind of a person makes a good inventor? Bruce believes that Bell had the right talents, including a knowledge of the mechanics of speech and the right opportunities, one being access to someone like Thomas A. Watson. Bell's role as a teacher of the deaf gave him contacts with Gardiner Hubbard and Thomas Sanders, both of whom helped convert the invention to a successful innovation by creating the corporate structure that made Bell rich. Bell married Hubbard's daughter, and it was Bell's eagerness to succeed in the world for her sake that was the driving force that was the impetus to completing his invention.

At one point in the development of the telephone, Bell lamented his ignorance of electricity and was grateful for Joseph Henry's encouragement to gain the necessary knowledge. Later in life Bell declared that if he had known more about electricity he would not have conceived of the idea of the telephone. This ignorance of scientific theory has been such a common occurrence in the history of technology—the many examples in electricity include the telegraph, the incandescent light, and the radio—that the historian is tempted to propose a theory of imposed ignorance as a basis for all initial inventions. Bell's biography is another example of the unpredictability of invention. There are no ways to train inventors or to know beforehand who will be a successful inventor.

The telephone is a good case against trying to force innovation. Engineering development can work through planning, but Bell was a failure as an engineer. His search from the outset was for a method of

increasing the message-carrying capacity of the telegraph. He failed in that but succeeded by accident in transmitting voice.

Bell was wise enough to see that he had no capacity for technological innovation; he turned the management of his patents over to his father-in-law, Hubbard, going so far as to establish a blind trust. Bell's fame spread with the telephone. He became an international figure who was received by Queen Victoria and the Emperor of Japan. Universities gave him honorary degrees. Bell's story is that of the inventor as hero, where society bestowed wealth and honors, not commensurate with his talents, but for the usefulness others discovered in his invention. How many young men dazzled by Bell's fame set out to emulate him is part of the social history of those times.

Half of this book is devoted to Bell's struggles in developing a patentable idea and defending his patent rights. The rest of the story is about a celebrity who unavailingly tried to repeat his achievement. Bruce writes well, and in all parts of the biography he tells interesting stories. The one serious weakness of this book is that it is far too long. No one wants to read about a sequence of failures, even if the subject had once succeeded very well. The historian of technology will find little profit in reading beyond part 2 unless he is interested in studying more closely why inventors fail. Bell failed in his later ventures because he did not carry his ideas through to a workable stage, he did not consider the need to make his ideas commercially sound, and, alas, most of his ideas, such as his efforts at producing an airplane, were technically flawed. All these are aspects of failure well known to the historian of technology.

If Alexander Graham Bell had not invented the telephone would he be remembered today and would a full-scale biography of him be written? No. Would the telephone have been invented if Alexander Graham Bell had not lived? Yes. Bell, just as all inventors, did not leave his personal mark on technology. By contrast, scientists such as William Thomson (later Lord Kelvin) did formulate theories that were uniquely of their own creation. The electromagnetic theory of light would have borne a different mark had James Clerk Maxwell not lived. Biographies can humanize the people in the history of technology, but only the social history can humanize technology.

Bell wanted to be remembered as a teacher of the deaf, and in his work in fostering the teaching of speech to the deaf he left his personal mark. But if that were all he had done he would not be commemorated through the means of a large-scale biography. Half of his life story is worth telling and worth reading.

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